PANEL SPACER

Field of the Invention

[0001] This invention relates to a spacer that is configured to be secured to a panel.

Background of the Invention

[0002] In the aerospace industry, a premium is placed upon lightweight and strong structural components. For example, a floor of an aircraft must be lightweight and strong. The floor must also accommodate the stresses imposed upon the bulkhead by the flexing of the wings during flight. The aircraft industry uses composite or sandwich panels that are fastened to spars and bulkheads by a large number of fasteners that are secured to the panels by extending through corresponding spacers mounted in the panels. Frequently, the sandwich panels are formed of thin aluminum face sheets with expandable aluminum foil strips that form the core. Alternatively, laminated plastic resin upper and lower surface face sheets are provided that sandwich a honeycomb core of resin and paper. Both configurations provide excellent strength to weight or stiffness to weight relationships in comparison to solid metallic panels. Alternative face sheets or skins for sandwich panels can include steel, titanium, magnesium, aluminum alloys, and alloy steels, while cores can also be formed of plastic foam, balsa wood, high temperature alloys and steel foil. Generally, the

core is honeycomb and has hexagonal cells with walls perpendicular to the face sheets.

[0003] Composite panels are frequently used in aircraft with high-strength, high-modulus, fiber-reinforced, thermoset or thermoplastic resins. As can be appreciated, when a composite structure is used as a floor panel or wall panel in an aircraft, it is frequently necessary to fasten objects to the panels. Thus, a number of different fasteners and spacers have been developed to accommodate resin sandwich panels and to prevent a localized concentration of loading.

[0004] Prior art spacers have been relatively costly since the spacers were manufactured from machined bar stock. Machining bar stock is a time consuming process and wastes metal. Conversely, the spacer of the present invention is manufactured from metal stampings which is a relatively efficient process and does not waste metal. Other prior art spacers were manufactured from plastic. Plastic spacers suffer from the limitation of not being as strong or resilient as metallic spacers.

[0005] Also, prior art spacers had a longer seat height in comparison to the seat height of the present invention. By using a shorter seat height, fasteners with a shorter shank can be used with the spacer of the present invention. Fasteners that have shorter shanks reduce the cost of the fastener and the weight of the fastener. Reducing the cost and weight of fasteners that are used to secure

panels on aircraft or other vehicles is desirable. Additionally, the use of a seat with a shorter seat height places the seat adjacent to the shear plane of the panel. This placement provides a fastened joint with a greater shear strength since the shear bending moment of the fastener would be reduced. The greater shear strength would permit the use of fewer spacers in the panel than prior art spacers. Using less spacers would also reduce the cost and weight of the overall combination of the panel with a plurality of spacers. Finally, the use of a seat with a shorter seat height permits the bore of the spacer to act as a guide for a tool inserting or removing a fastener from the spacer. With the bore acting as a guide, the tool slipping off a driving recess in the fastener is minimized and panel marring or scratching is avoided.

Summary of the Invention

[0006] It is an object of the invention to provide a spacer that is manufactured from an efficient process.

[0007] It is another object of the invention to provide a spacer that is manufactured from a process that does not waste metal.

[0008] It is another object of the invention to provide a spacer with a shorter seat height.

[0009] It is another object of the invention to provide a spacer that uses fasteners with a shorter shank than prior art spacers.

[0010] It is another object of the invention to provide a spacer with a seat height that is located adjacent to the shear plane of the panel.

[0011] It is an another object of the invention to provide a spacer that acts as a guide for a tool inserting or removing a fastener from the spacer.

[0012] These objects of the invention are achieved by providing a spacer that is configured to be secured to a panel of a predetermined thickness with a bore. The spacer has a first piece having a generally tubular body portion of a preselected height, H_1 with a first end and a second end. The second end has a preselected included angle, θ with respect to an axis that passes through a bore of the first piece. The spacer has a second piece having a first end, an annular ridge which is located adjacent to the first end and a flange which is located adjacent to the annular ridge that extends radially outwardly from the axis. The first end of the second piece has a preselected height, H_3, a preselected included angle, θ with respect to the axis and a seat which is adapted to receive the head of a fastener. The second end of the first piece is sandwiched between the first end of the second piece and the annular ridge.

Brief Description of the Drawings

[0013] FIG. 1 is a cross-sectional view of the spacer of the invention;

[0014] FIG. 2 is a cross-sectional view of the spacer of the invention;

[0015] FIG. 3 is a perspective isometric view of the spacer of the invention;

[0016] FIG. 4 is a cross-sectional view of the spacer of the invention showing a fastener threadedly engaging a nut disposed in another panel;

[0017] FIG. 5 is a perspective isometric view of exemplary flange configurations that could be used with the spacer of the invention;

[0018] FIG. 6 is a partial cross-sectional view of the spacer of the invention showing the punch and anvil used to secure the spacer together; and

[0019] FIG. 7 is a partial cross-sectional view of the spacer of the invention showing the punch and anvil used to secure the spacer together.

Detailed Description of Preferred Embodiments

[0020] With reference to FIG. 1, a spacer 10 is shown mounted on a panel 12. The height of the spacer 10 can vary depending upon the particular thickness of the panel 12. As shown in FIG. 2, the spacer 10 is provided with a preselected height, H_1 which is greater than the thickness of the panel 12 so when a flange 14 of the spacer is adhered to the panel 12 with an adhesive 16, a first end 18 of a preselected height, H_2 of the spacer 10 may be cold-worked or deformed by a tool of a particular configuration to permit the end 18 of the spacer 10 to be curled into the panel 12 to secure the spacer 10 to the panel 12 as shown in FIG. 1. The installed spacer 10 is also shown in FIG. 3. Typically, the installed spacer 10 has a clearance fit within the bore of the panel 12.

[0021] The spacer 10 is of a two piece construction that is manufactured

from metal stampings. One piece prior art spacers were either manufactured from machined bar stock or plastic. As can be appreciated, machining bar stock is a relatively time consuming process as compared to stamping metal. Also, much metal is wasted in machining bar stock. As can be appreciated, plastic spacers suffer from the limitation of not being as resilient or strong as metallic spacers. Two piece prior art spacers were manufactured with a machined bar stock component and a metal stamping. The machined bar stock component suffers from the same limitations as a one piece machined bar stock spacer.

[0022] As shown in FIG. 1, a first piece 20 of the spacer 10 has a general tubular body with a bore 22. The end 18 of the first piece 20 is curled into the panel and a second end 24 may be bent at a preselected included angle, θ of about 100° relative to an axis 26 that passes through the bore 22. While θ is shown with an angle of 100°, θ may have a value of anywhere from about 80° to about 130° relative to the axis 26. The range of from about 80° to about 130° is intended to cover points that fall within that range as well. In an alternative embodiment, θ may have a value of about 180° in those applications that call for use of a protruding head fastener.

[0023] The end 24 is sandwiched between an annular ridge 28 of a second piece 30 and a first end 32 of the second piece 30. The end 32 is also bent at a preselected included angle, θ of about 100° relative to the axis 26. As with the

first piece 20, the second piece 30 may have a θ value of anywhere from about 80° to about 130° relative to the axis 26. The range of from about 80° to about 130° is intended to cover points that fall within that range as well. In an alternative embodiment, θ may have a value of about 180° in those applications that call for use of a protruding head fastener. The second piece 30 also has a seat 34 which is configured to receive the head of a fastener 38.

[0024] As shown in FIG. 4, the shank of the fastener 38 would extend through a bore 36 for engagement with a nut 40 or a clip nut. Adjacent to the annular ridge 28 is a radially extending flange 14 which is secured to the panel 12 with the adhesive 16. Traditionally, prior art spacers typically used circular flanges. In this invention, the flange 14 may be easily manufactured to accommodate different load paths at different locations on the panel 12. For example, see FIG. 5 which shows various alternative configurations for the flange 14 of the spacer 10. As shown in FIG. 5, the flange 14 may be circular or any non-circular shape as well. Since the second piece 30 is a stamping, the specific load path can be custom made for any application at minimal cost.

[0025] The seat 34 has a preselected height, H_3 which is much shorter than prior art seats used in spacers. In the prior art, the seat was typically placed adjacent to the end 18 that is curled into the panel 12. H_3 of the present invention is about 75% shorter than prior art seat heights placed adjacent to the end 18. In

other words, H_3 has a height of about 25% of the height of H_1. In an alternative embodiment, H_3 of the present invention may have a height of anywhere from about 60% to about 80% shorter than prior art seat heights placed adjacent to the end 18. The range of from about 60% to about 80% is intended to cover points that fall within that range as well. In other words, H_3 may have a height of from about 20% to about 40% of the height of H_1. The range of from about 20% to about 40% is intended to cover points that fall within that range as well.

[0026] The seat 34 is located adjacent to a shear plane 40 of the panel 12. By providing the seat 34 with a shorter height, H_3 than prior art designs, it is possible to use fasteners 38 that have a shorter shank or overall length than the fasteners used with prior art spacers. Fasteners 38 that have shorter shanks reduce the cost of the fastener 38 and the weight of the fastener 38. Reducing the cost and weight of fasteners 38 that are used to secure panels 12 on airplanes and other vehicles is desirable. Also, the use of a seat 34 with a shorter height, H_3 adjacent to the shear plane 40 of the panel 12 would provide a fastened joint with greater shear strength since the shear bending moment of the fastener 38 would be reduced. The greater shear strength would permit the use of fewer spacers 10 in the panel 12 than prior art spacers. Using less spacers 10 would also reduce the cost and weight of the overall combination of the panel 12 with a plurality of spacers 10. Additionally, the use of a seat 34 with a shorter height, H_3 adjacent to

the shear plane 40 of the panel 12 allows the fastener 38 to be disposed in the bottom of the spacer 10 with the bore 22 acting as a guide for a tool inserting or removing the fastener 38 from the spacer 10. With the bore 22 acting as a guide, the tool slipping off a driving recess 42 in the fastener 38 is minimized and panel 12 marring or scratching is avoided.

[0027] The spacer 10 of this invention is manufactured as follows. The first piece 20 is manufactured from a metal blank that is pushed through a die to yield a drawn tubular metal component. The drawn tubular metal component is optionally trimmed. The second end 24 of the tubular metal component is bent with a punch and a complementary shaped anvil to a preselected included angle, θ. θ may have any of the value provided above. The second piece 30 is manufactured in a stamping machine. The flange 14 configuration of the second piece 30 is selected. Tooling to blank a sheet of metal in the shape of the desired flange 14 configuration is inserted into the stamping machine. A sheet of metal is inserted into the stamping machine. A punch and a complementary shaped anvil stamps annular ridge 28 into the sheet of metal. Next, a hole punch punches a hole into the stamping to create bore 36 in piece 30. The first end 32 of the second piece 30 is optionally trimmed after the hole punching step. Next, the sheet of metal is blanked with a tool and complementary shaped anvil into the desired flange 14 configuration. Next, the first piece 20 is placed on the second

piece 30 such that the end 24 rests on the annular ridge 28. As shown in FIGS. 6-7, an anvil 44 is disposed in annular ridge 28 of the second piece 30 while a punch 46 is advanced downwardly to sandwich the second end 24 between the annular ridge 28 and the first end 32 to yield the spacer 10.

[0028] Having described the presently preferred embodiments of the invention, it is to be understood that the invention may be otherwise embodied within various functional equivalents within the scope of the appended claims.

[0029] What is claimed is: